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RESEARCH NOTE

Self-adhesive wire markers for bivalve tag and recapture studies

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Abstract: Bivalves are good candidates for tag and recapture studies because the accrual of shell material provides a stable record of growth. Obtaining measurements for tagged individuals over time relies on the resilience of markings or tagging devices to environmental stress as well as the readability of identifying markings upon capture. Tagging devices should also be easy and quick to apply in order to minimize potential stress to the animal during extirpation from the water. A variety of methods to attach devices to the inside and outside of bivalve shells have been used in tagging studies. This paper describes a low cost, commercially available, self-adhesive numbered tag for application to clams and other bivalves. Tests of the tag demonstrate its resilience to severe conditions over a short time scale with a ninety-five percent recovery of individuals with tags remaining intact. Ninety-four percent recovery of individuals with tags intact was also achieved in long-term studies. No problems with legibility of tags recovered occurred in any of the tests.

Key words: shell, numbering, clam, enumeration, individuals

Tag and recapture studies are important methods for a wide range of physiological and ecological research applications, such as accurate measures of growth and survival of individuals within populations. Tagging methods for bivalves can be classified into two main categories, internal and external. Placement of internal tags within shell cavities, such as passive integrated transponder tags (Kurth *et al.* 2007), is much less common than external application. Internal tags are generally more costly, require some sort of locator/reader or destructive sampling for recapture, and can stress the animal more during device application than externally applied tagging devices.

External tagging does not require relaxation to open shell valves for internal tag insertion, possible rejection of the tag by the animal, or specialized locating equipment, unlike internal tags that cannot be found by visual observation. External tagging of bivalves is practical because of the hardness and stable surface area of the shell. Many approaches to external tagging involve physical alteration of the shell surface, such as engraving (McMahon and Williams 1986, Mattice and Wright 1986) or permanent dye markers and paints (Buttner and Heidinger 1980). Other methods require adhesives, such as numbered bee-type tags (Lemarie *et al.* 1995, Kurth *et al.* 2007), electronic Passive Integrated Transponder (PIT) tags (Kurth *et al.* 2007), monofilament tags (Layzer and Heinricher 2004), and anchored tethers attached to the shell (Foe and Knight 1986). Other monofilament tags anchor into shell ligaments without the use of adhesives (Lim and Sakurai 1999). Problems with external tags include decreased tag legibility/recovery resulting from abrasion with sediments and stress from handling due to drying times necessary for adhesives. To avoid tags altogether, cages with numbered slots for individual clams have been used (Foe and Knight 1986, Cataldo *et al.* 2001).

In this study, we tested the use of self-adhesive markers (originally designed for marking electrical wire) for tagging bivalves. Thomas & Betts Brand EZ-Code® Wire Markers (Product #WM-0-90, Thomas & Betts Inc., USA) were chosen because of their small size, readability, self-adhesive strength, and low cost (pack of 455 tags for about US$32 = $0.07 per tag). These self-adhesive, vinyl-coated cloth tags are intended for identification of wires, breakers, and service panels in the electrical industry and are therefore widely available through local and online electrical products suppliers.

The tags have 4 mm-tall black numbers with a 5 mm^2 white background and a thickness of less than 0.5 mm. There are a variety of numbers, letters, and combination number/letter schemes available (see the Thomas & Betts internet-based catalog, www.tnb.com). The tags are applicable for bivalve studies, even for small-sized animals such as *Corbicula fluminea* (Müller, 1774) since the tags are small but are readable without magnification (Fig. 1) and stand out in contrast to untagged clams and substrates. Because of the ease of application, the out of water time of the test organisms is minimal. The tag application also causes less shell damage than engraving and time out of water than paint and traditional liquid adhesive/tag applications.

Two tests were performed to evaluate the durability of the markers for bivalves: (1) exposing tagged individuals to short-term extreme physical stress conditions and (2) longer-term

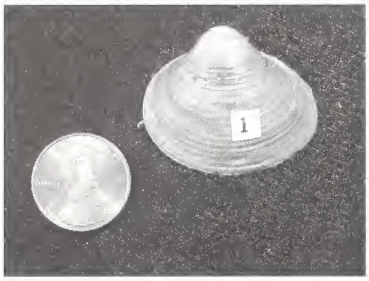

Figure 1. Tag applied to clam shell.

exposure of tagged bivalves to simulated natural environments in stream-type flumes. The freshwater clam (*Corbicula* sp.) was used as the test organism. Tags were applied to the middle of one shell valve of clams that had been towel-dried. Tags were allowed to cure for approx. 10 seconds to ensure adhesion, even though it was found that individuals could be submersed in water without the loss of the tags directly after application. No external coatings or adhesives were added to the tags prior to placement onto the shells. The legibility of the numbers on each tag was noted after each experiment.

The first test of durability was performed on a sample of 20 live clams obtained from the Santa Fe River at The Rapids, near High Springs, Florida in December 2001. The animals were placed in a 1-L Nalgene® bottle along with 200 mL of coarse-grade sand and 200 mL of water. The mixture was capped and shaken vigorously by hand for 15 minutes, after which the clams were removed for inspection. Nineteen of 20 clams retained their tags for a 95% recovery with no loss of legibility. All clams exhibited chipping around shell margins with exposure of soft tissue, suggesting that the conditions in this test were harsher than those normally encountered in most natural environments.

In long-term tag exposure experiments, 972 tagged clams were stocked in large, sand-bottom, outdoor aquaculture raceways. Water velocities in the raceways ranged from 0.013 to 0.020 m s^{-1}, and water depths were maintained at 0.2 m. A total of 324 clams were stocked in each of 3 separate experiments, for time periods of 440 days, 290 days, and 210 days in June 2002, November 2002, and February 2003, respectively. Stocks were obtained from locations in the Santa Fe River at Sandy Point, Florida, Lake Dalhousie near Umatilla, Florida, and Lake George near Astor, Florida. Clams were tagged and distributed in a stratified random fashion in the input, middle, and output sections of each raceway. Of the 972 tagged individuals, only 55 tags were not unaccounted for at the end of the experiments, or a 94% recovery. All of the tags attached to clam shells remained legible.

The durability, longevity, and readability of tags in this study indicates the self-adhesive tags are an ideal method for assessing the dynamics and condition of bivalves in aquaculture or for natural populations. A large percentage of the tags remained intact on the surface of the clam shells and remained legible after exposure to both extreme conditions and long-term exposure. We suggest the Thomas & Betts EZ-Code Wire Markers are an acceptable alternative for use in tag and recapture studies of bivalves in natural and engineered systems.

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